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(54) **INTERFACE ELEMENT BETWEEN A BLADE ROOT AND A BLADE ROOT HOUSING OF A TURBINE DISC, AND TURBINE ROTOR COMPRISING AN INTERFACE ELEMENT**

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F01D 5/08 (2006.01)

(52) **U.S. Cl.**

CPC ***F01D 5/3092*** (2013.01); ***F01D 5/081*** (2013.01); ***F01D 5/3007*** (2013.01); *F05D 2240/81* (2013.01); *F05D 2250/70* (2013.01); *F05D 2250/71* (2013.01); *F05D 2260/20* (2013.01); *F05D 2260/30* (2013.01); *F05D 2260/36* (2013.01); *F05D 2260/941* (2013.01); *F05D 2260/96* (2013.01)

(58) **Field of Classification Search**

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USPC 416/224, 248
See application file for complete search history.

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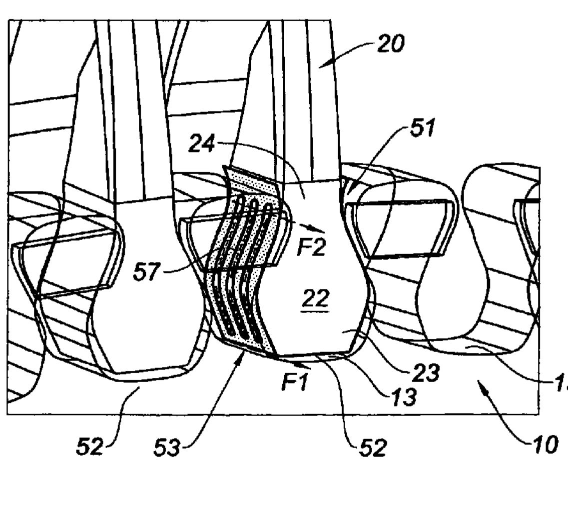
(57) **ABSTRACT**

An interface element to be mounted between a blade root and a blade root housing provided in a turbine disc of a gas turbine engine to limit wear between the root and the housing. The interface element includes: a base, configured to be aligned with a lower part of the root; and first and second upper side walls connected to the base and configured to surround the blade root up to an upper portion thereof, the first upper side wall including at least one ventilation opening to allow a flow of cooling air flowing through the rotor disc housing to flow over the upper portion of the root via the ventilation opening.

9 Claims, 3 Drawing Sheets



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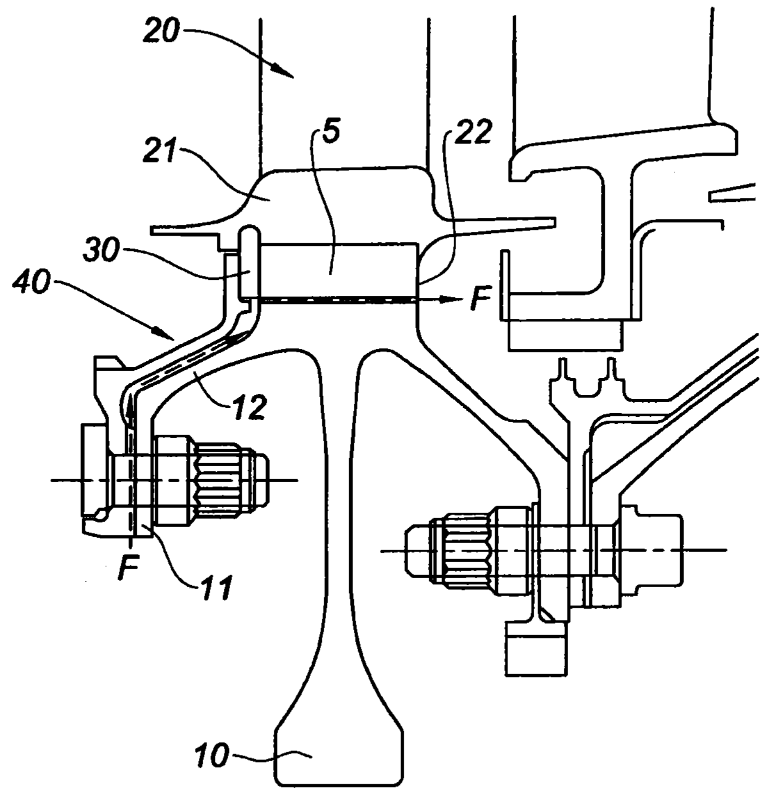

Fig. 1

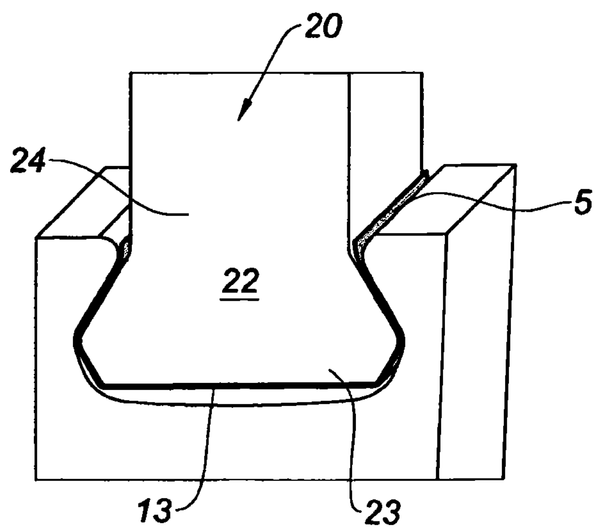

Fig. 2

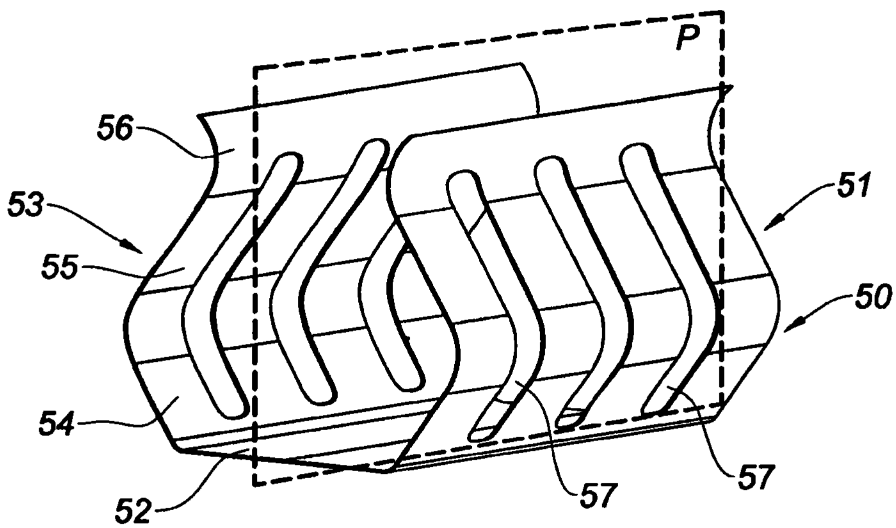

Fig. 3

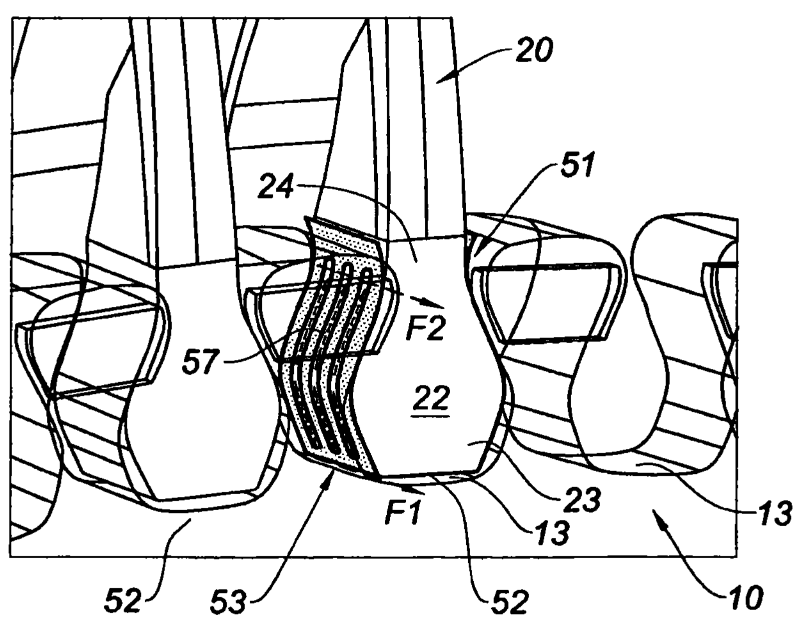

Fig. 4

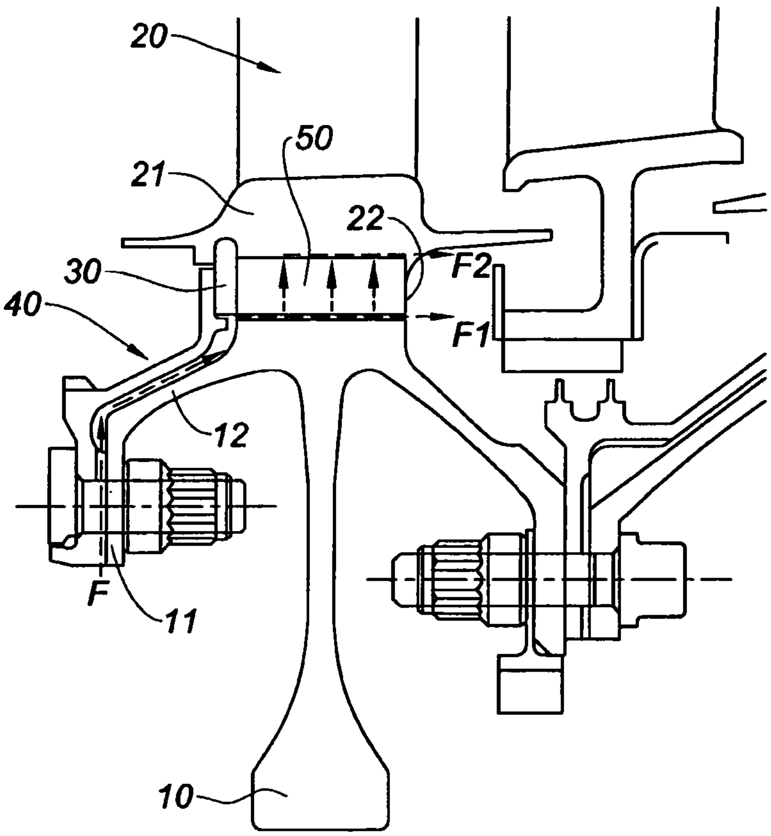

Fig. 5

INTERFACE ELEMENT BETWEEN A BLADE ROOT AND A BLADE ROOT HOUSING OF A TURBINE DISC, AND TURBINE ROTOR COMPRISING AN INTERFACE ELEMENT

The invention relates to the field of turbine machine rotors and, more particularly, cooling of the rotor blades on a rotor disc.

A front blower double body turbojet engine, for example, conventionally comprises, from upstream to downstream, a blower, a low pressure compressor stage, a high pressure compressor stage, a combustion chamber, a high pressure turbine stage and a low pressure turbine stage.

By convention, in the present application, the terms "upstream" and "downstream" are defined with respect to the air circulation direction in the turbojet engine. Also, by convention, in the present application, the terms "internal" and "external" are radially defined with respect to the engine axis. Thus, a cylinder extending according to the engine axis comprises an internal side turned up to the engine axis and an external side opposed to the internal side thereof.

Referring to FIGS. **1** and **2**, a low pressure turbine stage, for example, comprises successive rotor discs **10** each comprising axial or oblique grooves **13**, being known from the man of the art under the name of recess, within which roots **22** of blades **20** are housed, the blades **20** radially extending outside with respect to the engine axis. Such grooves **13** are also called housings **13** further on.

Each rotor disc **10** comprises "whiskers" arranged on either part of the disc **10** and called upstream whisker and downstream whisker further on. The upstream whisker of the rotor disc **10** is formed by a radial annular flange **11** connected to the upstream side of the rotor disc through an annular frusto-conical ferrule **12** being flared upstream.

Referring to FIGS. **1** and **2**, the roots **22** of the blades **20** are radially retained in the grooves **13** through their bulbous section, so-called a dovetail. A metal interface element **5**, being known from the man of the art as "shim" located between the root **22** of the blade **20** and the bottom of the groove **13**, as shown on FIG. **2**, is arranged to restrain wear against the blade root **22** and the internal surface of the groove **13** of the rotor disc **10**.

The interface element **5** comprises a full bottom wall and two full upper side walls being connected to the bottom wall so as to enclose the root **22** of the blade **20** so as to avoid that the external surface of the root **22** is in contact with the internal surface of the housing **13**.

The roots **22** of the blades **20** are axially retained by an upstream ring axially abutting on an upstream part of the roots **22** of the blades **20**. The ring **30** is radially retained in radial hooks arranged in the platform **21** of the blades **20** and axially by a flange **40** holding the ring **30**.

The flange **40** covers externally the upstream frusto-conical ferrule **12** of the rotor disc **10**, thereby allowing the rotor disc **10** to be thermally protected against the high temperature of gases exiting from the combustion chamber of the engine.

Referring to FIG. **1**, a cooling channel is arranged between the flange **40** and the upstream ferrule **12** of the rotor disc **10** so as to guide a fresh air flow F, taken in upstream from the low pressure turbine stages within the housings **13** of the blades **20** arranged in the rotor disk. Air F circulates in the grooves **13** under the interface elements **5** enclosing the roots **22** of the blades **20** so as to protect them against excessive temperatures. The circulation of the fresh air flow F is represented by arrows on FIG. **1**, the fresh air flow F opening downstream from the rotor disc **10** between the root **22** of the blade **20** and the housing bottom **13**.

The cooling channel allows the lower part **23** of the roots **22** of the blades **20** to be cooled efficiency, i.e. the radially lower part **23** of the root **22** which is the closest of the bottom of the grooves **13** of the rotor disk **10** as represented on FIG. **2**.

On the contrary, the upper part of the rotor disc **10** facing the upper part **24** of the root **22** of the blade **20**, i.e. the radially external part **24** of the root **22** which is the closest of the platform **21** of the blades **20** is not sufficiently cooled, the fresh air flow F not circulating in the vicinity of the upper part **24** of the root **22** of the blade **20** and the upper part of the rotor disc **10**.

To solve this problem, the patent application EP 1,464,792 A1 is known, learning a low pressure turbine for a gas turbine engine comprising radial housings formed in the rotor disc to receive the blade roots. In order to allow a cooling of the upper part of the blade root, the root comprises an internal ventilation channel radially extending in the root and opening, in the one side, into the lower wall of the lower part of the root and, on the other side, in the side wall of the upper part of the root so as to allow fresh air flow to cool the root internally. In other words, each blade root comprises an internal ventilation channel arranged to communicate the lower part of the blade root with the upper part thereof.

An internal ventilation channel weakens the blade root being submitted to very important mechanical and thermal constraints.

Moreover, the blade of the patent application EP 1,464,492 A1 needs a housing adapted to allow the air flow from the ventilation channel to cool the upper part of the rotor disc. Thus, such a blade cannot be used for turbine engines which are already in circulation and the housings of which have conventional shapes.

In order to eliminate at least some of such drawbacks, the invention relates to an interface element adapted to be mounted between a blade root and a blade root housing arranged in a turbine disc of a gas turbine engine to limit the wears between the root and the housing thereof, the interface elements comprising a bottom wall adapted to correspond with a lower part of the root, and two upper side walls connected to the bottom wall and adapted to enclose the blade root up to a upper part of the root, wherein at least one first upper side wall comprises at least one ventilation opening with a configuration to allow a cooling air flow circulating in the housing of the rotor disc to circulate on the upper part of the root via said ventilation opening.

Thanks to the invention, the interface element fulfills a double function. It allows, on the one side, to restrain the wear between the root and the housing thereof and, on the other side, to cool the upper part of the rotor disc being submitted to high temperatures. Furthermore, the presence of a ventilation opening in the upper side wall allows the thermal conductibility of the calories to be restrained from the upper part of the root towards the lower part thereof. In other words, the presence of a ventilation opening allows the heat resistance of the interface element to be increased.

Furthermore, the overall dimensions of the interface element according to the invention are substantially identical to those of the interface element according to the prior art. An interface element according to the invention can thus advantageously be mounted on a circulating engine to improve the cooling of the blade root.

The modification of the interface element to improve cooling allows the modification of the rotor to be restrained to only one part, the rotor disc or the blade being not advantageously modified.

According to one aspect of the invention, said ventilation opening is rectilinear.

According to another aspect of the invention, said ventilation opening extends according to the height of the first side wall. Advantageously, the lower part of the blade root communicates with the upper part of the blade root.

Preferably, said ventilation opening extends over 30% to 90% of the height of the first side wall.

According to the invention, the second side wall comprises a ventilation opening arranged facing the ventilation opening of said first side wall. Consequently, both side walls of the blade root are simultaneously cooled.

According to another aspect of the invention, said upper side wall comprising at least two ventilation openings, the dimensions of the ventilation openings are identical.

The invention also relates to a rotor for a gas turbine engine comprising a rotor disc including at least one housing in which a blade root is housed, on which a previously presented interface element is mounted to restrain the wears between the root and the housing thereof.

Preferably, the root having a dovetail shape, each upper side wall comprising a base portion, connected to the bottom wall, and an intermediate portion connected to the base portion by a bent portion, said ventilation opening is continuous between the base portion and the intermediate portion of the first upper side wall. The lower part of the blade root is advantageously in communication with the upper part of the blade root.

According to one aspect, a cooling air flow circulating from upstream to downstream, in the housing of the rotor disc, the ventilation opening extends obliquely in the upper side wall of a radially internal upstream part towards a radially external downstream part of said upper side wall. Thus, the cooling air flow is deviated obliquely from the lower part of the root towards the upper part thereof.

According to another aspect, a cooling air flow circulating from upstream to downstream in the housing of the rotor, an upper side wall of the interface element comprising at least an upstream ventilating opening and a downstream ventilation opening, the dimensions of the upstream opening are bigger than the dimensions of the downstream opening. The cooling air flow rate is more important upstream, thereby allowing the cooling air flow to reach quicker the upper part of the root to cool it upon its circulation from upstream to downstream.

Other characteristics and advantages of the invention will appear in the following description relative to the accompanying drawing given as a non limitative example, wherein:

FIG. **1** is a longitudinal sectional view of a rotor for a gas turbine engine in which a blade root, with an interface element according to the prior art, is mounted in a housing of a rotor disc, the circulation of a cooling air flow according to the prior art being represented (already discussed);

FIG. **2** is a view of the blade root with the interface element according to the prior art, being mounted in the housing of the rotor disc (already discussed);

FIG. **3** is a perspective representation of an interface element according to the invention;

FIG. **4** is a perspective view of a rotor of a gas turbine engine, wherein a blade root, with an interface element according to the invention is mounted in a housing of a rotor disc, the rotor disc being represented in transparency; and

FIG. **5** is a longitudinal sectional view of the rotor of FIG. **4**, the circulation of a cooling air flow according to the invention being represented.

An interface element **50** adapted to be mounted between a root **22** of a blade **20** and a housing **13** of the blade **20** root **22** arranged in a turbine disc **10** of a gas turbine engine is represented referring to FIG. **3**.

The interface element **50**, preferably in metal, comprises a bottom wall **52** adapted to be in contact with an upper part **23** of the root **22**, and two upper side walls **51**, **53** connected to the bottom wall **52** and adapted to enclose the root **22** of the blade **50** up to an upper part **24** of the root **22**. When the interface element **50** is mounted on the root of the blade **20**, it allows the wears between the root **22** and the housing **13** thereof to be restrained.

Subsequently, the terms "left" and "right" are defined with respect to FIG. **4** representing the interface element **50** in a mounted position in a turbine rotor according to the invention, only the left side wall **53** being visible on FIG. **4**.

Still in reference to FIG. **4**, the turbine rotor comprises a rotor disc **10** extending in a radial plane with respect to the axis of the engine, comprising a plurality of radial housings **13** arranged on the periphery of the rotor disc **10**. Such housings **13** are known from the man of the art under the name of recesses. Radial blades **21** are arranged on the rotor disc **10** so as to be driven in rotation by the rotor **10**. With this end in view, each blade **20** comprises a head adapted to accelerate a hot air flow circulating within the engine and the root **22** adapted to be mounted in the rotor disc **10**.

In such example, each root **22** of a blade **20** is radially retained in the housing **13** thereof by its bulbous section, so called a dovetail, the housing **13** having a complementary shape to this of the root **22** of the blade **20**. It goes without saying that the housings **13** of the turbine disc **10** and the roots **22** of the blades **20** can be of various shapes, the important being that the root **22** cooperates with its housing **13** by a shape complementarity so as to keep a radial support of the blade **20** with respect to the turbine disc **10**.

In this example, referring to FIG. **3**, each side wall **51**, **53** of the interface element **50** comprises consecutively a rectilinear base portion **54** being connected to the bottom wall **52**, an intermediate rectilinear portion **55** and a rectilinear free portion **56**, the intermediate rectilinear portion **55** being connected to the base portion **54** and to the free portion **56** by bent parts. In other words, each side wall **51**, **53** presents two inflection points so as to allow the dovetail-shaped blade root **22** to be enclosed.

As represented on FIG. **4**, the root **22** of the blade **20** comprises a lower part **23** being radially internal, and an upper part **24**, being radially external and with a weaker section than the section of its lower part **23**. The interface element **50** is arranged to enclose the root **22** of the blade **20** while covering its left side surface, its lower surface and its right side surface so as to prevent the root of the blade **20** to be in direct contact with the internal surface of the housing **13** of the turbine disc **10**. With this aspect in view, the interface element **50** substantially has the same longitudinal length as the root of the blade **20** for which it is intended.

The side walls **51**, **53** of the interface element **50** radially extend up to the upper part **24** of the blade root **22**. In other terms, the free end of each side wall **51**, **53** of the interface element **50** extends up to the periphery of the rotor disc **10** so as to protect the whole side surface of the blade root **20**. The base portion **54** of each side wall **51**, **53** covers the lower part **23** of the blade root **22**, whereas the intermediate portion **55** of each side wall **51**, **53** covers the upper part **24** of the blade root **20**.

As previously indicated, due to the circulation of the hot air flow in the vicinity of the head of the blade **20**, the temperature of the upper part **24** of the root **22** of the blade **20** is higher than the one of the lower part **23** thereof.

Referring to FIG. **5**, a cooling air flow F circulates from upstream to downstream in the housings **13** of the turbine disc **10** so as to cool the interface element **50** by thermal conduction. According to the invention, the side walls **51**, **53** of the interface element **50** are perforated so as to allow the circulation of the cooling air flow F on the side surface of the blade root **22**, while preventing the frictions between said blade root **22** and the housing **13** thereof.

Advantageously, the perforated interface element **50** also allows the heat resistance thereof to be increased, while restraining heat conduction from the upper part **24** of the blade root **22** towards the lower part **23** thereof.

Referring to FIG. **3**, the right **51** and left **53** upper side walls each comprise three ventilation openings **57** with such a configuration to allow the cooling airflow F circulating in the housing **13** of the rotor disc **10** to cool the upper part **24** of the root **22** via said ventilation openings **57**.

The invention is presented in this example with three ventilation openings **57** arranged in each of the upper side walls **51**, **53** of the interface element **50**, but the invention also aims at any interface element **50** comprising at least one ventilation opening **57** in at least one upper side wall **51**, **53**. In particular, the invention aims at an interface element with one single ventilation opening **57** arranged in one single upper side wall **51**, **53**.

In this example, referring to FIG. **3**, each ventilation opening **57** of one same side wall **51**, **53** extends continuously from the base portion **54** to the intermediate portion **55** of said side wall **51**, **53**. Thus, each ventilation opening **57** allows the lower part **23** of the blade root **22** (in contact with the base portion **54**) to communicate with its upper part **24** (in contact with the intermediate portion **55**). The cooling air flow allows the upper part **24** of the blade root **22** as well as the upper part of the rotor disc **10** which is thermally exposed, to be cooled.

It goes without saying that one ventilation opening **57** could extend over a unique rectilinear portion of each side wall **51**, **53**, over two consecutive portions or over the three ones. Moreover, a ventilation opening **57** could also extend in one side wall **51**, **53** and in the bottom wall **52**.

In this example, the ventilation openings **57** of a same side wall **51**, **53** are parallel with each other. In other terms, the openings within each of the portions **54**, **55**, **56** of said side wall **51**, **53** are parallel with each other. Moreover, the ventilation openings **57** of a same side wall **51**, **53** are regularly spaced apart. The shape of the ventilation openings **57** as well as their distribution allows the upper part to be homogeneously cooled over the whole longitudinal length of the blade root **22**.

The ventilation openings **57** are here substantially radial in the side walls **51**, **53** of the interface element **50**. In other words, each ventilation opening **57** belongs to a plane being transversal to the axis of the engine.

It goes without saying that the openings could also extend obliquely in a side wall **51**, **53**, preferably from a radially internal upstream part towards a radially external downstream part of said upper side wall **51**, **53**. With such oblique ventilation openings **57**, the cooling air flow F is conducted with a high flow rate from the lower part **23** towards the upper part **24**, thereby improving the transfers by thermal conduction.

In this example, the ventilation openings **57** have substantially the same dimensions, but the latter could be different. In particular, according to a non represented embodiment of the invention, the dimensions of the ventilation openings **57** are bigger in the upstream part of the interface element **50** than in the downstream part thereof.

Consequently, a cooling air flow with a more important flow rate circulates in the upstream ventilation openings, thereby allowing the airflow F to exchange calories with the upper part **24** of the root **22** by thermal conduction, while circulating longitudinally from upstream to downstream between the internal surface of the groove **13** and the upper part **24** of the root.

Referring to FIG. **3**, the interface element **50** presents a symmetry plane P extending over its length perpendicularly to its bottom wall **52** so that the right side wall **51** is symmetrical of the left side wall **53** with respect to the symmetry plane P. The ventilation openings **57** of the left side wall **53** are facing the ventilation openings **57** of the right side wall **54**. In a mounted position, the symmetry plane P is a longitudinal plane going through the axis of the engine.

When the interface element **50** is mounted on the blade root **22**, the left side surface of the blade root **22** is partially visible through the ventilation openings **57** as represented on FIG. **4**. In particular, the side surface of the lower part **23** and of the upper part **24** of the blade root **22** is visible, each ventilation opening **57** forming a cooling channel arranged to conduct the cooling air flow from the lower part **23** of the root **22** towards the upper part **24**.

Although the interface element **50** comprises ventilation openings **57**, this does not affect its interface function between the root **22** and its housing **13**, the root of the blade **22** never being in direct contact with the internal surface of the housing **13**. Preferably, a side wall **51**, **53** of the interface element **50** is not perforated to more than 40% of its whole surface.

The circulation of the cooling air flow F in the rotor will be detailed referring to FIG. **5**.

An inlet cooling air flow F is introduced upstream from the housing **13** and is divided, on the one side, into a main cooling air flow F**1** circulating longitudinally from upstream to downstream in the housing **13** to escape at a radial height of the lower part **23** of the blade root **22**, and, on the other side, into a plurality of elementary flows radially circulating towards outside in the cooling channels formed between the ventilation openings **57** of the interface element **50** and the internal surface of the housing **13**.

The elementary flows open at radial height of the upper part **24** of the blade root **22** to be then longitudinally driven from upstream to downstream, the plurality of the elementary flows forming an auxiliary cooling flow F**2** represented on FIG. **5**. The elementary flows cool the upper part **24** by thermal conduction not only upon their radial circulation, but also upon their longitudinal circulation from upstream to downstream.

Thanks to this implementation of the invention, the upper part **24** of the blade root **22** is advantageously cooled by an auxiliary cooling flow F**2** without modifying either the blade **20**, or the rotor disc **10**. The interface element **50** can thus be used for engines being presently in circulation to improve the cooling of the blades **20**.

Advantageously, when the dimensions of the ventilation openings **57** are more important in the upstream part of the interface element **50** than in the downstream part thereof, the auxiliary cooling flow rate F**2** is more important upstream from the upper part **24**, thereby improving the cooling of the blades.

The interface element **50** which was before only considered as a wearing element forms according to the invention a cooling tubing to allow the cooling air flow F to reach the upper part **24** of the blade root **22**.

The invention claimed is:

1. An interface element configured to be mounted between a root of a blade and a housing of the root of the blade arranged in a turbine disc of a gas turbine engine to restrain wear between the root and the housing thereof, the interface element comprising:

a bottom wall configured to correspond with a lower part of the root; and

first and second upper side walls connected to the bottom wall and configured to enclose the blade root up to a upper part of the root, wherein at least the first upper side wall includes at least one ventilation opening with a configuration to allow a cooling air flow circulating in the housing of the rotor disc to circulate on the upper part of the root via the ventilation opening.

2. The interface element according to claim **1**, wherein the ventilation opening is rectilinear.

3. The interface element according to claim **1**, wherein the ventilation opening extends over 30% to 90% of a height of the first upper side wall.

4. The interface element according to claim **1**, wherein the second upper side wall includes a ventilation opening arranged facing the ventilation opening of the first upper side wall.

5. The interface element according to claim **1**, wherein the first upper side wall includes at least two ventilation openings, and dimensions of the ventilation openings are identical.

6. A rotor of a gas turbine engine comprising:

a rotor disc including at least one housing, in which a root of a blade is housed, on which an interface element is mounted according to claim **1** so as to restrain wear between the root and the housing thereof.

7. The rotor according to claim **6**, wherein the root has a dovetail shape, each upper side wall including a base portion connected to the bottom wall, and an intermediate portion connected to the base portion by a bent portion, the ventilation opening is continuous between the base portion and the intermediate portion of the first upper side wall.

8. The rotor according to claim **6**, wherein a cooling air flow circulates from upstream to downstream in the housing of the rotor disc, the ventilation opening extends obliquely in the first upper side wall from a radially internal upstream part towards a radially external downstream of the upper side wall.

9. The rotor according to claim **6**, wherein a cooling air flow circulates from upstream to downstream in the housing of the rotor disc, the first upper side wall of the interface element includes at least one upstream ventilation opening and one downstream ventilation opening, dimensions of the upstream opening are more important than dimensions of the downstream opening.

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